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(54) Labels and manufacture thereof.

(57) A method of producing a succession of self-adhesive labels carried on a length of release material, the method including the steps of: (a) digitally printing a succession of images on a web; and (b) die-cutting the web to form a succession of self-adhesive labels on a length of release material. There is also provided a method of producing a succession of self-adhesive labels carried on a length of release material, the method including the steps of:- (a) digitally printing a succession of images on a web; (b) cutting the printed web into a succession of labels; and (c)applying the succession of labels to a second web including a release material. There is further provided an apparatus for producing a succession of self-adhesive labels on a length of release backing material, the apparatus comprising a digital printing unit for printing a web with a succession of images and a die-cutting device for cutting self-adhesive labels from the web.

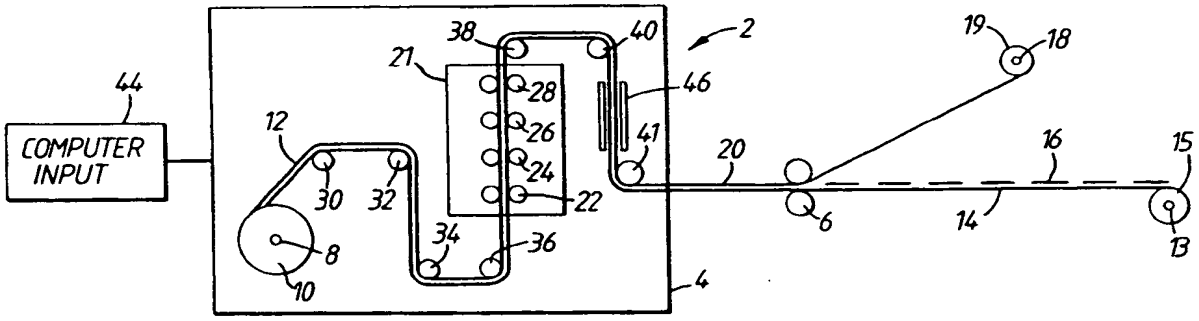

Fig.1

EP 0 684 130 A2

The present invention relates to a method of and an apparatus for producing self-adhesive labels and to self-adhesive labels.

The manufacture of printed and die-cut self-adhesive labels carried in succession on a length of release backing material, such as silicone-coated paper, has been known for many years. In such known processes, a reel of labelstock material, comprising a web of self-adhesive paper on a backing of release material, is passed through a single or multicolour web printing machine so as to print a succession of label images on the upper surface of the paper web and then, downstream of the printing station or stations in the machine, the paper web is die-cut at a die-cutting station and the waste matrix of self-adhesive paper surrounding the labels is stripped off the release material. The release material carrying the succession of die-cut self-adhesive labels is then wound up into a reel.

Historically, such labels have been printed either by a flexographic printing process or by a rotary letterpress printing process. In these processes mechanical alteration of the printing press is necessary if different repeat lengths are printed. For both of these printing processes, when it is required to change the printed image or change the repeat length of the printed image, a significant amount of make ready time is required to set up the printing press. Thus both the flexographic and rotary letterpress printing processes for the manufacture of self-adhesive labels are only commercially suitable for the manufacture of high volumes of self-adhesive labels in long print runs and with fixed repeat lengths in the labels produced. A further problem in the use of these two printing processes, particularly the flexographic printing process, is that the printing quality is often not particularly high, and specifically not sufficiently high to enable high quality printed images, particularly pictures, to be printed on the labels.

In order to overcome these problems of the known flexographic and rotary letterpress self-adhesive label manufacturing processes, in my EP-A-0098092 I devised a method and apparatus for producing self-adhesive labels in which a succession of individual lithographically-printed sheets were adhered to a length of labelstock material, and then the sheets themselves and the self-adhesive paper of the labelstock material were cut and the waste matrix removed thereby to form self-adhesive labels on a release material. These labels, in having lithographically printed images, enabled a higher quality printed image to be achieved than with the earlier flexographic and rotary letterpress printing techniques. In addition, the method and apparatus of that invention were particularly suitable for the manufacture of small volumes of labels. This is because the sheets were separately printed on an offset lithographic sheet printing press and then a selected number of the sheets were applied to the labelstock web. In addition, the use of a sheet printing process in combination with the subsequent adhesion of the sheets to the web enables the ultimate labels to have variable repeat lengths. However, this earlier label manufacturing process requires two separate manufacturing steps i.e. sheet printing and then label manufacture.

It would still be advantageous in the art for lithographically-printed self-adhesive labels to be made using a web printing process rather than by employing a sheet printing process with the subsequent sheets being assembled onto a web.

In recent years offset lithography label presses have become available in commerce. In order to manufacture labels having variable repeat lengths, it is required that the printing cylinders are retracted from the web after each printing cycle and are moved, for example by a servomotor, so as to be radially repositioned. This enables the printing repeat to be varied. However, these lithographic label presses are both complicated and expensive. Furthermore, the lithographic printing cylinders still require long make ready times when the label image is to be changed, making the web offset lithographic label presses only commercially suitable for long print runs.

There is thus still a need for a method and apparatus for producing high quality printed self-adhesive labels on a length of release material which readily enables either short or long print runs to be manufactured efficiently and cost effectively. There is also still a need for such method and apparatus which enable variable print lengths and variable printed images to be utilised without significant make ready times.

The present invention aims at least partially to satisfy these needs.

Accordingly, the present invention provides a method of producing a succession of self-adhesive labels carried on a length of release material, the method including the steps of: (a) digitally printing a succession of images on a web; and (b) die-cutting the web to form a succession of self-adhesive labels on a length of release material.

The present invention further provides a method of producing a succession of self-adhesive labels carried on a length of release material, the method including the steps of:- (a) digitally printing a succession of images on a web; (b) cutting the printed web into a succession of labels; and (c)-applying the succession of labels to a second web including a release material.

The present invention still further provides apparatus for producing a succession of self-adhesive labels on a length of release backing material, the apparatus comprising a digital printing unit for

printing a web with a succession of images and a die-cutting device for cutting self-adhesive labels from the web.

The present invention further provides apparatus for producing a succession of self-adhesive labels on a length of release material, the apparatus comprising a digital printing unit for printing a succession of images on a web, a cutting device for cutting the web into a succession of labels, and label applying device for applying the labels to a web including a release material.

The present invention yet further provides a succession of self-adhesive labels carried on a length of release material, successive labels having at least two alternating digitally printed images.

Embodiments of the present invention will now be described by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic side view of an apparatus for producing self-adhesive labels in accordance with a first embodiment of the present invention;

Figure 2 is a plan view of self-adhesive labels carried on a length of release backing material produced in accordance with an embodiment of the invention using the apparatus of Figure 1;

Figure 3 is a schematic side view of an apparatus for producing labels in accordance with a second embodiment of the present invention;

Figure 4 is a section on line A-A of Figure 3;

Figure 5 is a section on line B-B of Figure 3;

Figure 6 is a schematic side view of an apparatus for producing self-adhesive labels in accordance with a further embodiment of the present invention; and

Figure 7 is a schematic representation of the control system of the apparatus of Figure 6.

Referring to Figure 1, there is shown an apparatus, designated generally as 2, for the manufacture of printed self-adhesive labels in accordance with a first embodiment of the present invention.

The apparatus 2 comprises a printing unit 4 and a die-cutting and waste removal unit 6. A roller 8 in the printing unit 4 is provided for mounting a supply reel 10 of labelstock material 12 to be printed, a rewind roller 13 is provided for mounting a reel 15 of the release backing material 14 of the labelstock material 12 carrying a succession of self-adhesive labels 16 thereon and a waste wind up roller 18 is provided for supporting a reel 19 of the waste matrix 20, formed from the self-adhesive paper web 22 of the labelstock material 12, which waste matrix 20 is removed from the release material 14 at the die-cutting and waste removal station 6. In accordance with the invention, the printing unit 4 is a digital printing apparatus which includes a plurality of printing stations in a printing engine 21. In the illustrated embodiment there are four printing stations 22,24,26,28 which are each arranged to print a respective colour, or black, on one or both sides of the labelstock material 12. The printing unit 4 also includes a drive system, including rollers 30,32,34,36,38, 40,42 for controllably conveying the web of labelstock material 12 through the printing unit 4 and to the die-cutting and waste removal unit 6. The printing stations 22,24,26,28 are digital printing stations, working preferably with a dry toner process (although optionally with a wet ink process) which typically are similar to those employed in colour photocopiers or laser printers. The printing process may be a direct or offset digital process. The printing stations 22,24,26,28 are controlled by a computer input 44 which, together with computer software, controls the printing engine 21 of the printing unit 4, and the drive system so as to ensure that the desired images are printed on the web 12. The computer input 44 may include computer terminals set up with commercially available publishing software. The printing unit 4 together with its associated computer input 44 are available in commerce from Agfa-Gevaert N.V. of Belgium under the trade name Chromapress. Alternative printing units are available from Xeikon N.V. of Belgium or Indigo of the Netherlands. The printing stations 22,24,26,28 employ an electrophotographic imaging process wherein a dry toner is applied to the web 12 to be printed by a rotating drum. The printed image is digitised and divided into an array of pixels which permits an extremely high quality image to be produced. The dry toner is fused onto the paper web at a heating station 46 downstream of the printing engine 21.

The printing stations 22,24,26,28 are, unlike the printing cylinders of known flexographic, rotary letterpress and offset lithography self-adhesive label printing apparatus, seamless, i.e. there is no requirement for the printing drum to have a portion extending across its circumference which cannot be employed to print an image. This results in the significant technical advantage that the printing stations 22,24,26,28 can each print images having variable repeat lengths. In fact the printing stations 22,24,26,28 can be controlled to print an image of infinite length with an appropriate computer input. This means that the apparatus 2 for producing self-adhesive labels may be employed in a first run to produce a succession of self-adhesive labels having a first repeat length and then, with an appropriate command from the computer input 44, may then be used in a second run to produce different labels having a different repeat length, this being achieved without the requirem nt between the runs for mak ready time to modify the printing unit as would be r quired in th known flexographic, web

154,156 at least one of which is in turn driven by a feed motor 202 so as to move folded labels 122 in succession from the input end 146 at which folded labels 122 are received from the folding unit 148 to the output end 144 at which folded labels 122 are fed onto the self-adhesive web 112 between the rollers 118,120.

The folding unit 148 is of generally known construction and comprises a zig-zag array of folding rollers 158 together with a zig-zag array of folding pockets 160 on opposed sides of the array of rollers 158. In use, the folding rollers 158 rotate continuously to drive a sheet through the folding unit 148. In use, a sheet 162 is fed through the uppermost pair of rollers 158 and into the uppermost folding pocket 160. When the leading edge of the sheet 62 hits the end of the folding pocket 160, the sheet 162 continues to be fed by the rollers 158 and the initially flat sheet 162 is then upset by this continued feeding so as to have a folded configuration with a single fold. The location of the fold in the sheet 162 is determined by the depth of the folding pocket 160. The single folded sheet 162 s then fed by the next pair of rollers 158 (i.e. the second and third rollers) in the zig-zag array into the second folding pocket 160 and in the same way a second fold line is formed. This process continues until the desired folded sheet 162 is achieved, the sheet having a number of fold lines corresponding to the number of folding pockets 160. The resultant fully folded label 122 is then fed out from the lowermost pair of rollers 158 between the endless belts 150,152 of the label feed system 126.

The folding unit 148 is supplied continuously with printed sheets 162 which have been formed from a single printed web 164 which is fed out from a printing unit 166 having the same configuration as the printing units of the embodiments of Figures 1 and 3. If desired, in order to provide additional pages in the ultimate label, the web 164 has been longitudinally plough folded prior to forming of the printed sheets. The printing unit 166 is controlled by a computer input 167. The web 164 is thus printed on one or both sides by a digital printing technique. The printed web 164 is fed to a festoon 170 at which a supply length of the printed web 164 is tensioned. The web 164 then passes between a drive roller 172 and an upper opposed roller 174 of a web feed system 171 which feeds the web intermittently to a cutting device 176 comprising a cutting roller 178 and an opposed backing roller 180. The cutting device 176 cuts off a desired length of the printed web to form a separate printed sheet 162 which is then fed into the folding unit 148. The operation of the web feed system 171 and of the printing unit 166 ar coupled together whereby the printed web 164 is fed on demand to the web feed system as and when required.

The drive roller 172 is driven by an electromagnetic clutch 175 which has its input shaft 177 continuously driven. The electromagnetic clutch 175 is actuated intermittently so as to rotate the drive roller 72 when the printed web 164 is required to be fed through the cutting device 176.

The feed motor 202 continuously drives not only at least one of rollers 154,156 thereby continuously rotating the endless belts 150,152 of the label feed system 126 but also continuously drives the folding rollers 158 of the folding unit 148 and the input shaft 177 of the electromagnetic clutch 175 of the drive roller 172 for the printed web 164. Preferably, the driven roller or rollers 154,156, the folding rollers 158 and the input shaft 177 are mechanically geared together, thereby providing a mechanical coupling between the web feed system 171, the folding unit 148 and the label feed system 126.

The apparatus 102 includes a number of sensors, with associated control systems, for controlling and coordinating the operation of the various parts of the apparatus 102. A printed web sensor 182 is provided between the festoon 170 and the drive roller 172 for the printed web 164. The sensor 172, which is typically a photodetector, is adapted to detect a series of printed marks along the printed web 164. The detection of each printed mark causes a detection signal to be generated which switches off the electromagnetic clutch 175 for the drive roller 172 and actuates the cutting device 176 when the web 164 has stopped. The cutting device, and the web drive, are thereby operable in response to a detection signal from the sensor. This ensures that accurately cut printed sheets 162 are formed from the printed web 164, each printed sheet 162 having the required length and being registered with respect to the printing on the web 164. The web 164 is then moved again through the cutting device 176 after a short delay in the next cycle by actuation of the electromagnetic clutch 175 for the drive roller 172.

A second sensor 184 is provided in the label feed system 126 and is adapted to detect each folded label 122 as it passes along the label feed system 126. The sensor 184 is typically a photodetector which is adapted to detect either an edge, for example the leading edge, of each folded label 122 or a printed registration mark on each folded label 122. The second sensor is adapted to control the application of the folded label 122 to the self-adhesive web 112 so that it is in registry with the die-cutting roller 134. This registration is employed when the web 109 is not pre-printed, precut or otherwise provided with a succession of registration points along the length of the web 109.

The second sensor 184 controls the application of the folded label 122 by varying the speed of the feed motor 202 in the manner described below. The variation of the speed of the feed motor 202 causes corresponding speeding up or slowing down of the web feed system 171, the folding unit 148 and the label feed system 126 which are coupled together.

An embodiment of a control system for controlling and coordinating the operation of the label feed system 126, together with the web feed system 171 and the folding unit 148, the web conveying system and the die-cutting roller 134 of Figure 6 will now be described with reference to Figure 7. The web conveying system 186 comprises a main motor 188 which drives the take-up reel 104 and preferably at least one of the supply reel 110, the guide rollers 114,142 and the rollers 120 and 136. A speed setter 190 inputs a digital signal into the main motor 188 representative of the desired web speed. The main motor 188 is connected to an encoder 192 which is adapted continuously to output a series of pulses, the instantaneous rate of which is related to the actual speed of the main motor 188. The pulses are received by a motor control 194 which compares the instantaneous pulse rate with the rate of the desired set speed and if there is a difference in those two rates, the motor control 194 outputs a feedback signal which is received by the main motor 188 and instantaneously corrects the speed of the main motor 188.

This feedback control provides continuous instantaneous control of the speed of the main motor 188 so that at any given time the actual speed is the same as the desired set speed.

The encoder 192 also outputs a pulse signal, comprising a series of pulses at a particular rate, to a pulse counter 196. Each pulse is representative of a specific angular rotation of the main motor 188 and thus is representative of a specific distance which the labelstock web material has moved as a result of being driven by the main motor 188.

The pulse counter 196 outputs a series of pulses to a ratio selector 198. However, in an alternative arrangement, the series of pulses could be outputted directly to the ratio selector 198 from the encoder 192. The ratio selector 198 can be set to a predetermined ratio, typically to four decimal places, so that the pulse rate output therefrom is a predetermined ratio of the pulse rate input from the pulse counter 196. The output of pulses from the ratio selector 198 is fed to a motor control 200 for a feed motor 202 of the label feed system 126. The motor control 200 outputs a pulsed motor control signal to the feed motor 202 and th feed motor 202 rotates at a speed governed by the pulse rate of the pulsed motor control signal. In this way, the pulsed motor control signal controls the feed motor 202 and thereby the rate at which folded printed labels 122 are delivered onto the self-adhesive web 112 by the label feed system 126. The rate at which the printed web 164 is fed by the web feed system 171, thereby controlling the rate at which printed sheets 162 are fed into the folding unit 148, and the rate of operation of the folding unit 148 are also correspondingly controlled because the web feed system 171 and the folding unit 148 are geared to the label feed system 126.

In a manner similar to that of the main motor 188, the feed motor 202 is connected to an encoder 204 which is adapted continuously to output a series of pulses, the instantaneous rate of which is related the actual speed of the feed motor 202. The pulses are received by the motor control 200 which compares the instantaneous pulse rate with the rate of the desired set speed. If there is a difference in the two pulse rates, the motor control 200 outputs a feedback signal which may be positive or negative depending on whether the feed motor 102 is running slow or fast. The feedback signal is added arithmetically to the pulsed input from the ratio selector 198 to form the pulsed motor control signal which is fed to the feed motor 202. Thus the pulsed motor control signal may be continuously varied to ensure that the feed motor 202 is running at a speed that is at the desired ratio of the speed of the main motor 188. It will be understood that the motor control 200 also acts as a pulsed signal accumulator.

In this way the web conveying system and the label feed system can be arranged to run at a set speed ratio, the speed ratio being related to the length of each finished label, the length of each folded label which is applied to the web and the spacing between the folded labels on the web.

The label feed system 126 is also controlled with respect to the die-cutting roller 134 so as to ensure that when each folded printed label 122 is applied to the self-adhesive web 112, the folded printed label 122 is applied at substantially the correct position, irrespective of any fluctuations or variations in the position of the folded printed labels upstream of the sensor 184 in the label feed system 126 and the folding unit 148, so that when the folded printed label 122 is cut by the die-cutting roller 34 at the die-cutting station 132, the die-cut is substantially in registration with the folded printed label 122.

The die-cutting roller 134 is provided with a die-sensor 206. The die-sensor 206 detects when the die-cutting roller 134 is at a prescribed angular orientation and thus correlates the die-cutting roller 134 with respect to a particular stage of the die-cutting cycle. For example, the die-sensor 206 may be arranged to emit a die-signal at the commencement of a rotary die-cutting operation. The die-

sensor 206 is adapted to input a die-sensor signal to the pulse counter 196 which triggers the pulse counter 196 into outputting a pulse count signal to a comparator 208. The folded label sensor 184 also sends a signal to the comparator 208 when it detects a folded label 122. The two signals from the pulse counter 196 and the folded label sensor 184 received by the comparator 208 are processed and compared to yield an error signal which is indicative of any distance which the actual position of the detected folded label 122 in the label feed system 126 leads or lags a desired position which is in registry with respect to the die-cutting roller 134. Such an error signal is outputted by the comparator 208 to the motor control accumulator 200 of the label feed system 126. This causes the feed motor 202 of the label feed system 126 to be instantaneously speeded up or slowed down thereby to advance or retard the application to the self-adhesive web 112 of the detected folded label 122 in the label feed system 126 so that that detected folded label 122 is applied to the self-adhesive web 112 at the correct position with respect to the downstream die-cutting operation by the die-cutting roller 134. In this label producing apparatus, the die-cutting roller 134 defines the position of the resultant self-adhesive labels 106 along the web of release material 104 and the position of the folded printed labels 122 is registered on the labelstock web 109 with respect to the die-cutting roller 134. Thus the folded printed labels 122 in the label feed system 126 chase the position of the die-cutting roller 134 and each folded printed label 122 is applied to a target position on the web 112 which is correlated to a subsequent die-cut made by the die-cutting roller 134.

The operating speeds of the printed web feed system 171 and the folding unit 148 are preset with respect to the set speed of the label feed system 126 so that folded sheets 122 are fed at a desired rate from the folding unit 148 into the label feed system 126, but those operating speeds are varied in synchronism with any variation in the actual speed of the label feed system as a result of the coupling of those components together.

In an alternative embodiment of the apparatus of Figure 6, the computer input 167 is provided with software to control not only the printing unit 164 but also the web feed system 171, the folding unit 148, the label feed system 126, the web conveying system 186 and the ratio selector 198, so that all the components of the apparatus are operated in synchronism by a common control unit. Thus for example the computer input 167 not only supplies printing control signals to the printing unit 164 but also web position and label feed rate control signals to the web conveying system and the label feed system.

In operation, the web drive unit 168 continuously feeds the printed web 164 into the festoon 170, and any slack in the web 164, as a result of the intermittent operating of the drive roller 172 as described below, is taken up by the web drive unit 168. The drive roller 172 feeds the printed web 164 through the cutting device 176 until the sensor 182 detects the next printed mark on the printed web 164. At this point, the desired length of the printed web 164 has been fed through the cutting device 176. The drive roller 172 is instantaneously stopped by the electromagnetic clutch 175 to stop the web movement through the cutting device 176 and the cutting roller 178 is actuated to cut the desired length from the printed web 164. The cut sheet 162 is then fed into the folding unit 148, folded to the desired folded configuration and then fed between the endless belts 150,152 of the label feed system 126. After the cutting operation, the web drive roller 172 is started again to commence the next feeding, cutting and folding cycle.

The label feed system 126 operates continuously and applies the succession of folded printed labels 122 onto the continuously moving web 112. As described hereinabove, the speed of the label feed system 126 is set to be a particular ratio of the speed of the web conveying system and the application of each folded printed label 122 to the web 112 is controlled with respect to the position of the die-cutting roller 134.

The folded printed sheets 122 are adhered to the self-adhesive web 112 by the self-adhesive laminar material 128 and then the combined assembly 131 is die-cut at the die-cutting station 132 and the waste 138 removed.

In an alternative arrangement, the printed web 164 may be cut to form printed sheets 162 with waste web portions between adjacent printed sheets 162. The cutting unit 176 may then be adapted to effect two cuts during one cutting cycle, the first cut to cut off the printed sheet 162 and the second cut to cut of a waste web portion. The waste web portion may be ejected from the web feed system or the folding unit and discarded. This arrangement may be employed when the printed web 164 is printed with a repeat length which is not the same as the length of the printed sheet. This enables the apparatus to utilise webs having fixed repeat lengths irrespective of variations in size of the printed sheets 162. This is an important advantage because it enables the use of webs printed with fixed repeat lengths to be used for varying lengths of printed sheets.

In alternative embodiments of the method and apparatus of Figure 6, an adhesive applicator may be provided to deposit adhesive onto the upper surface of the self-adhesiv web 112 or, when web 112 is omitted, the backing web 108, so as to

adhere the sheets 122 to the respective web. The adhesive may be applied as a continuous layer or as a succession of patches.

Claims

1. A method of producing a succession of self-adhesive labels carried on a length of release material, the method including the steps of:
   (a) digitally printing a succession of images on a web; and
   (b) die-cutting the web to form a succession of self-adhesive labels on a length of release material.

2. A method according to claim 1 wherein the web is self-adhesive and is carried on a backing of release material.

3. A method according to claim 1 wherein the web is adhered to a backing of release material between the printing and die-cutting steps.

4. A method according to any one of claims 1 to 3 wherein in the printing step different images are printed in alternation on the web.

5. A method according to any foregoing claim wherein the web is folded after the printing step.

6. A method according to any foregoing claim wherein continuously variable information is additionally printed on the web in the printing step.

7. A method according to any foregoing claim wherein the web is printed on both sides thereof.

8. A method of producing a succession of self-adhesive labels carried on a length of release material, the method including the steps of:-
   (a) digitally printing a succession of images on a web;
   (b) cutting the printed web into a succession of labels; and
   (c)applying the succession of labels to a second web including a release material.

9. A method according to claim 8 wherein the labels are folded between the cutting and applying steps.

10. A method according to claim 8 or claim 9 wherein the labels are further die-cut after being applied to the second web.

11. A method according to any one of claims 8 to 10 wherein the second web is a backing of release material.

12. A method according to any one of claims 8 to 10 wherein the second web is a labelstock web.

13. Apparatus for producing a succession of self-adhesive labels on a length of release backing material, the apparatus comprising a digital printing unit for printing a web with a succession of images and a die-cutting device for cutting self-adhesive labels from the web.

14. Apparatus according to claim 13 further comprising a laminating device for laminating the printed web to a web of release material.

15. Apparatus according to claim 14 further comprising a folding device for introducing at least one longitudinal fold into the printed web.

16. Apparatus for producing a succession of self-adhesive labels on a length of release material, the apparatus comprising a digital printing unit for printing a succession of images on a web, a cutting device for cutting the web into a succession of labels, and label applying device for applying the labels to a web including a release material.

17. Apparatus according to claim 16 further comprising a folding device for folding the labels before they are applied to the web.

18. A succession of self-adhesive labels carried on a length of release material, successive labels having at least two alternating digitally printed images.

19. A succession of self-adhesive labels according to claim 18 wherein selected labels are digitally printed with continuously variable information.

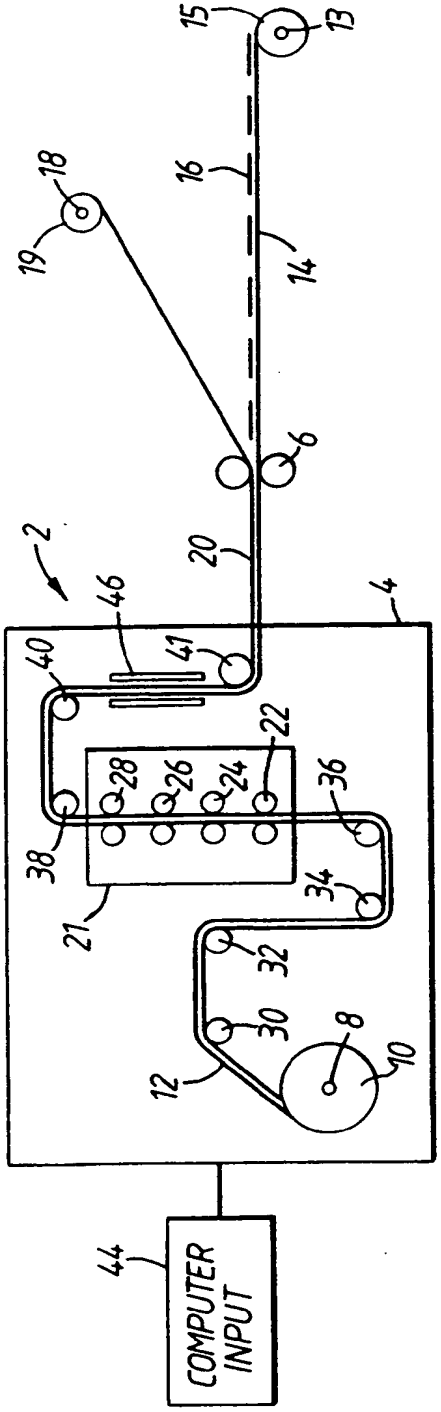
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Fig.1.

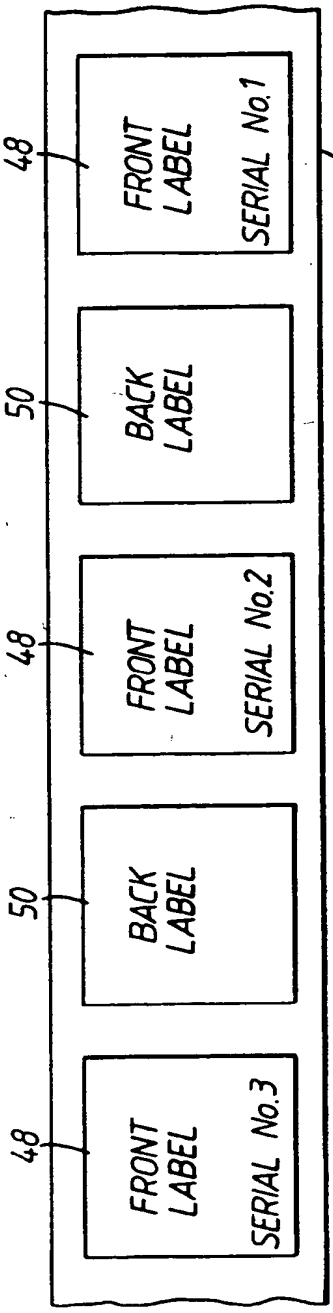
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Fig.2

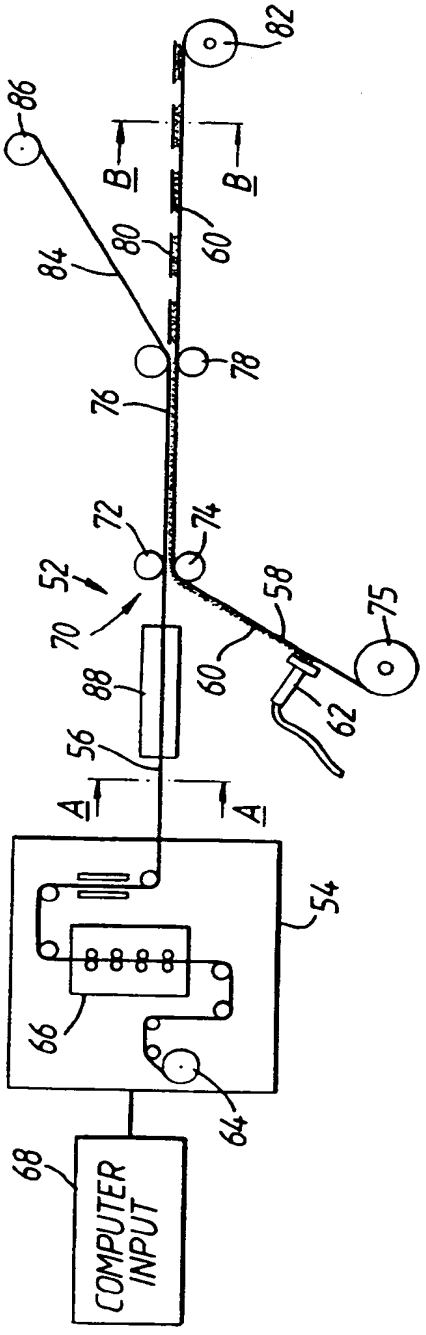

Fig.3

Fig.4

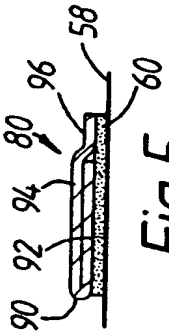

Fig.5

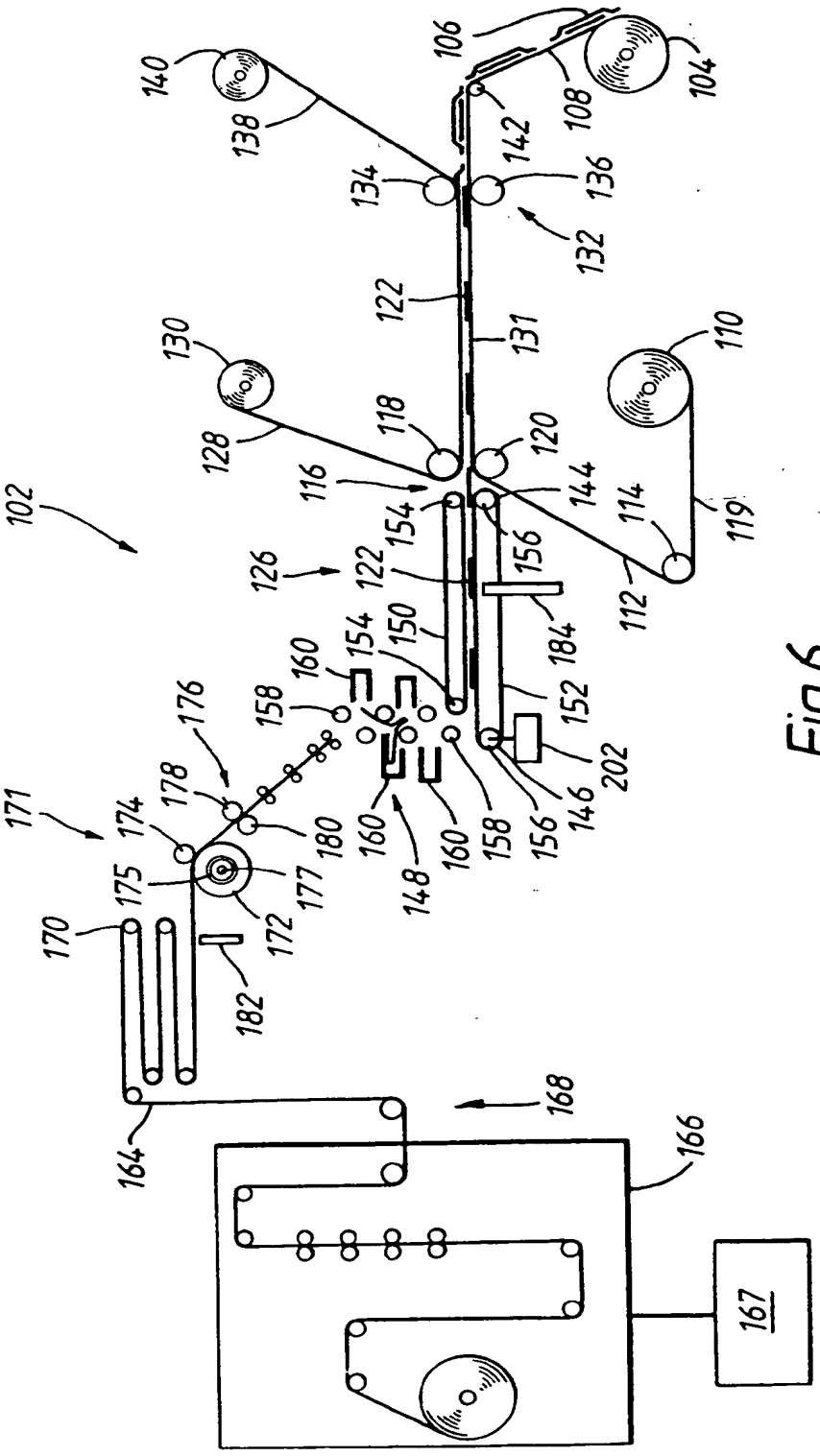
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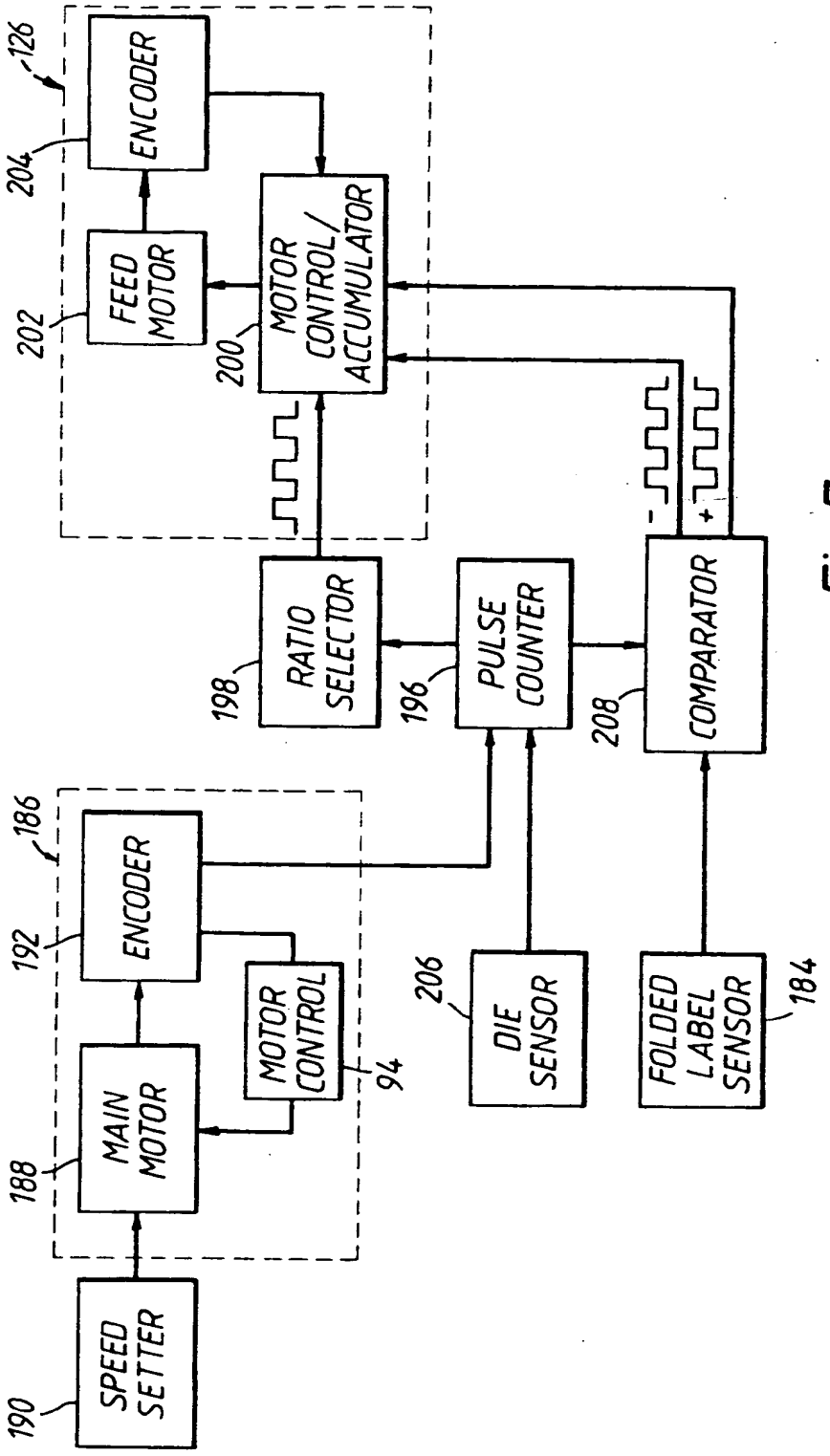
Fig.6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MOTOR CONTROL/ ACCUMULATOR
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PULSE COUNTER
196
COMPARATOR
208
186
ENCODER
192
MOTOR CONTROL
94
MAIN MOTOR
188
SPEED SETTER
190
DIE SENSOR
206
FOLDED LABEL SENSOR
184
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+

Fig.7